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PARANEBALIA BELIZENSIS, A NEW SPECIES FROM SHALLOW WATERS OFF BELIZE, CENTRAL AMERICA (CRUSTACEA: MALACOSTRACA: LEPTOSTRACA)

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Abstract.—*Paranebalia belizensis,* a new species of leptostracan from *Halimeda* habitats in the shallow waters surrounding Twin Cays, a mangrove archipelago in Belize, Central America, is described using the Dahl Model. Subtle, but consistant, differences separate *P. belizensis* from the ubiquitous *P. longipes.*

In shallow coastal waters of the western Atlantic Ocean and Caribbean Sea leptostracans of the genus *Paranebalia* are represented by a single known species, *P. longipes* Willemoes-Suhm (1875). This species has been reported from shallow waters off Bermuda (Willemoes-Suhm 1875, Sars 1887, Verrill 1923, Clark 1932), Virgin Islands (Thiele 1904), Bahamas and Southern Florida (Brattegard 1970). This paper uses Dahl's (1985) taxonomic model to describe a new species of *Paranebalia* from waters off Belize, Central America, in the western Caribbean Sea.

Specimens were obtained from a variety of locations in the Twin Cays archipelago. Masses of *Halimeda* growing on submerged parts of proproots of the red mangrove, *Rhizophora mangle,* were hand-collected and bagged. The algal masses were washed, piece by piece, in a bucket of seawater of ambient salinity and temperature. The residue remaining after the bucket water was filtered through a 0.2 mm mesh net bag was fixed in 7–10% Formalin, stained with Phloxine-B to facilitate sorting and transported to my Huntsville, Alabama laboratory. After sorting specimens were preserved in 70% ethanol.

A variety of measurements were made on specimens and their defining structures using an ocular reticle calibrated by a stage micrometer. Total length is the distance along the dorsal midline from the articulation of the rostrum to the posterior margin of the telson. Carapace length is the distance along the dorsal midline from the articulation of the rostrum to the margin of the posterodorsal cleft. Rostral length is measured along midline; width is measured across widest part of proximal half. Unless otherwise specified measurements on other structures are defined as follows: length is the longest linear distance between the ends of the structure and width the widest linear distance from side to side.

All statistical analyses were made using the ABSTAT Statistical Software package.

Paranebalia belizensis, new species
Figs. 1–5

Type material.—Twin Cays, Belize, Central American R. F. Modlin, 14 Jul 1989, Sample number 071489M31; Holotype 1 female, 3.3 mm total length (USNM 250527); Allotype 4 males, 1.7–2.1 mm (USNM 250528); Paratype 14 females, 1.4–3.6 mm and 3 ovigerous, 2.9–3.6 mm (USNM 250529).

Material examined.—Collected by R. F. Modlin at Twin Cays, Belize, Central America (16°04′N, 88°50′W). Sample numbers are composed, respectively, of month, day, year and station number, followed by the number of male-female-ovigerous-juvenile specimens examined: 1211588M31, 0-27-1-0; 121588M34, 2-70-0-8; 121788M30, 0-3-0-0; 121788M31, 0-5-1-0; 121788M34,

11-126-9-78; 070689M31, 12-109-6-57; 070689M34, 6-59-0-28; 071489M31, 15-76-3-11; 071489M35, 7-60-2-57.

Female.—Body robust, transparent, colored beige in living or preserved specimens, but eggs and ripe gonadal tissue color gravid females red. Carapace antero- (Fig. 1A) and posterolateral margins rounded without specialized spines, surface without any texture, posterodorsal cleft deep exposing all abdominal segments, anterodorsal margin articulating with rostrum, mean carapace length/total length ratio = 0.488 (standard error of mean = *SE* = 0.013, sample size = *n* = 52, range of carapace lengths (mm) measured = R = 0.6–1.75).

Rostrum (Fig. 1B) ovoid, broadly rounded in cross-section, apex with 1–2 subterminal spines, 2 obvious muscle scars near posterior margin, without sculpturing on dorsal or ventral surfaces, mean width/length ratio = 0.516 (*SE* = 0.013, *n* = 22).

Dentation of posterodorsal margin of pleonites 6 and 7 composed of triangular, sharply pointed denticles of equal length, denticle length = ca. 20 μm (Fig. 2).

Eyestalk (Fig. 1C) cylindrical, elongate, distal corneal region heavily armed with many robust spines, outer margin of proximal half with 5–7 small sharp spines; cornea oval, averages 49% of eyestalk length (*SE* = 3.0, *n* = 17).

Antennule peduncle (Fig. 1D) of 4 articles. Article 1 (not illustrated) small and inconspicuous; article 2 length/width ratio about 3.0, average length = 0.33 mm (*SE* = 0.03, *n* = 15), with distal clump of setae composed of about 12 short fine and 2 long thick setae; article 3 slightly shorter than article 2, average length 0.29 mm (*SE* = 0.03, *n* = 15), with 2 clumps of fine setae on distal half of lateral margin, 3 small setae on medial margin distally; article 4 short, average length 0.11 mm (*SE* = 0.02, *n* = 15), with lateral flange containing 7–10 robust denticles, inner edge of denticles with minute serrations. Antennule flagellum composed of 6 articles, proximal article about 6.7 times longer than others, 4 filiform esthetascs, 2 sets of paired pectinate setae and simple seta distolaterally, 3 simple setae dorsally; article 2 with filiform esthetasc, distolateral set of paired pectinate setae and simple seta, single simple seta dorsally; articles 3 to 6 each with set of paired pectinate setae and simple seta in distal lateral corner, and single simple seta dorsally; article 6 with 3 additional long naked terminal setae. Antennule scale blade-like, length/width ratio about 2.3, setose only on lateral and distal margins.

Antenna peduncle (Fig. 1E) composed of 3 articles, average length = 0.88 mm (*SE* = 0.07, *n* = 13). Article 1 short, inconspicuous; article 2 rectangular, length/width ratio about 2.4, average length = 0.31 mm (*SE* = 0.03, *n* = 13); article 3 longest, average length = 0.45 mm (*SE* = 0.03, *n* = 15), with 3 clumps of fine setae and 2 short robust spines on lateral margin, one long plumose seta at midlength of medial margin, and 4 plumose setae and minute spine on distomedial corner. Antennal flagellum of 5 articles, 0.65 times as long as peduncle, average length 0.58 mm (*SE* = 0.05, *n* = 15); proximal article average length = 0.23 mm (*SE* = 0.03, *n* = 15), 0.66 times longer than combined length of articles 2–5, fine setae arising from each articulation.

Mandibular palp (Fig. 3A) composed of 3 articles. Article 1 small, inconspicuous; article 2 curved, 1.1 times as long as article 3, with single long subterminal seta; article 3 margins nearly parallel tapering terminally, single terminal seta sharply curved medially, 2 rows of uniformly arranged robust setae along medial margin setae of both rows increasing in length distally, long pinnate inner row of setae originates in proximal ⅓, short naked outer row of setae originates in distal ⅓, 1 long straight terminally directed submarginal seta originates at midlength on each side of marginal rows of setae.

Maxillule (Fig. 3B) sympod with 2 endites; endite 1 flat, expanded, margin curved

Fig. 1. *Paranebalia belizensis,* new species: A, Anterior profile; B, Rostrum; C, Eye stalk; D, Antennule, a. serration on denticles of flange, b. setation on proximal 3 articles of flagellum; E, Antennal peduncle. Female, 3.3 mm.

with 10 long plumose setae and many minute hair-like setae; endite 2, pedestal-like with single subterminal plumose seta, articulates with short terminal segment with truncated distal margin containing row of robust spines. Palp composed of 3 articles; articles 1 and 2 short; article 3 very long, sharply flexed in proximal ⅙, inner margin with 13–14 long naked setae.

Maxilla (Fig. 3C) with 4 endites; endite 1, expanded, distal margin curved with long thin plumose setae; endites 2 and 3, rect-

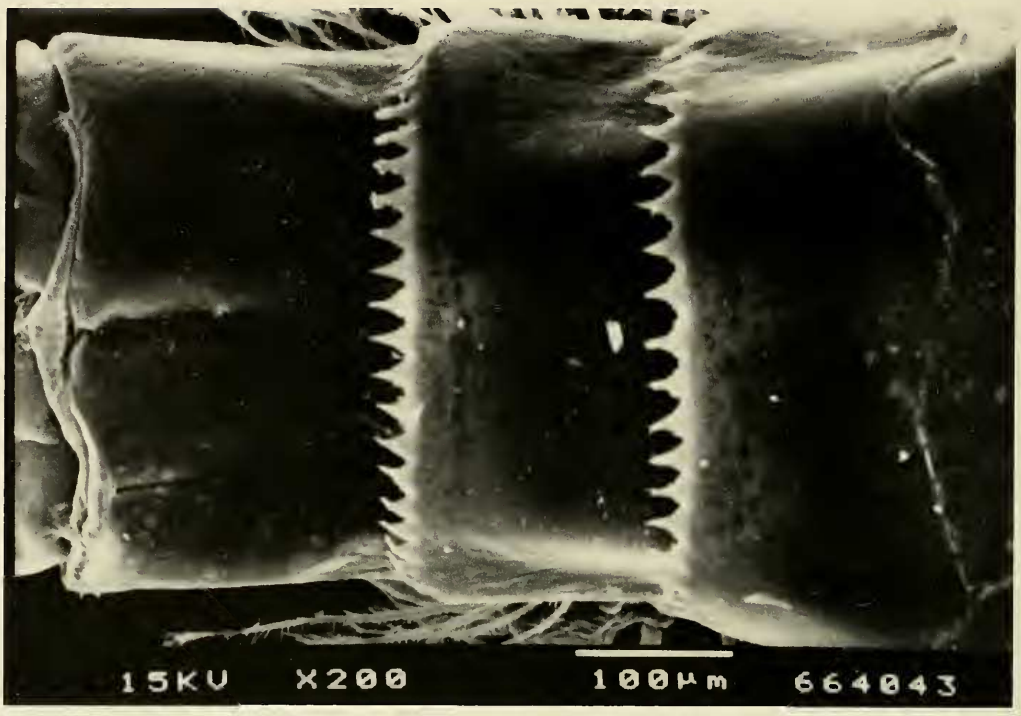

Fig. 2. *Paranebalia belizensis,* new species. Scanning electron micrograpy of dentition on the posterodistal margin of pleonites 6 and 7, and posterodistal margin of the telson. Female, 3.5 mm.

angular, distal margin truncate with long thin plumose setae; endite 4, short, rounded, distal margin with 2 long thick plumose setae and 1 long subterminal naked seta; endopod blade-like, composed of 2 articles, proximal about 0.5 times as long as distal, distal article with 3 long thick terminal plumose setae; exopod blade-like, outer and distal margins with 10 long, stout plumose setae.

Shape and size of thoracopods vary with life stage, but shape is characteristic of the genus. Figures 3D to F outline thoracopods 1, 4 and 8 from a mature non-gravid female. Sympods phyllopodous, medial margin setose with paired thin pinnate setae; epipods small, narrow, setose with many short naked setae along lateral margin; exopod of thoracopods 1 and 8 about ½ as long as endopod, exopod of thoracopods 2 to 7 about 0.8 times as long as endopods, all narrow, tapering distally, lateral margin setose with stiff pennate setae; endopods narrow, tapering distally, medial margin and distal half of lateral margin heavily setose with paired thin pinnate setae. Marginal setation is the same on all thoracopods. However, it is of little taxonomic value, since these setae exhibit drastic transformations during the female sexual cycle (Dahl 1985).

Pleopod 1 (Fig. 4A) peduncle dorsal surface with submarginal serration composed of 7–8 denticles laterally; exopod 0.68 times as long as endopod (SE = 0.02, n = 15), lateral margin with compact row of spines increasing in length distally terminating with single robust spine with minute subterminal flagellum, distal margin with 1 long flexed and 2 shorter subequal spines each with minute subterminal flagellum, 3 subterminal setae distally; endopod 0.94 times as long as peduncle (SE = 0.3, n = 15), with

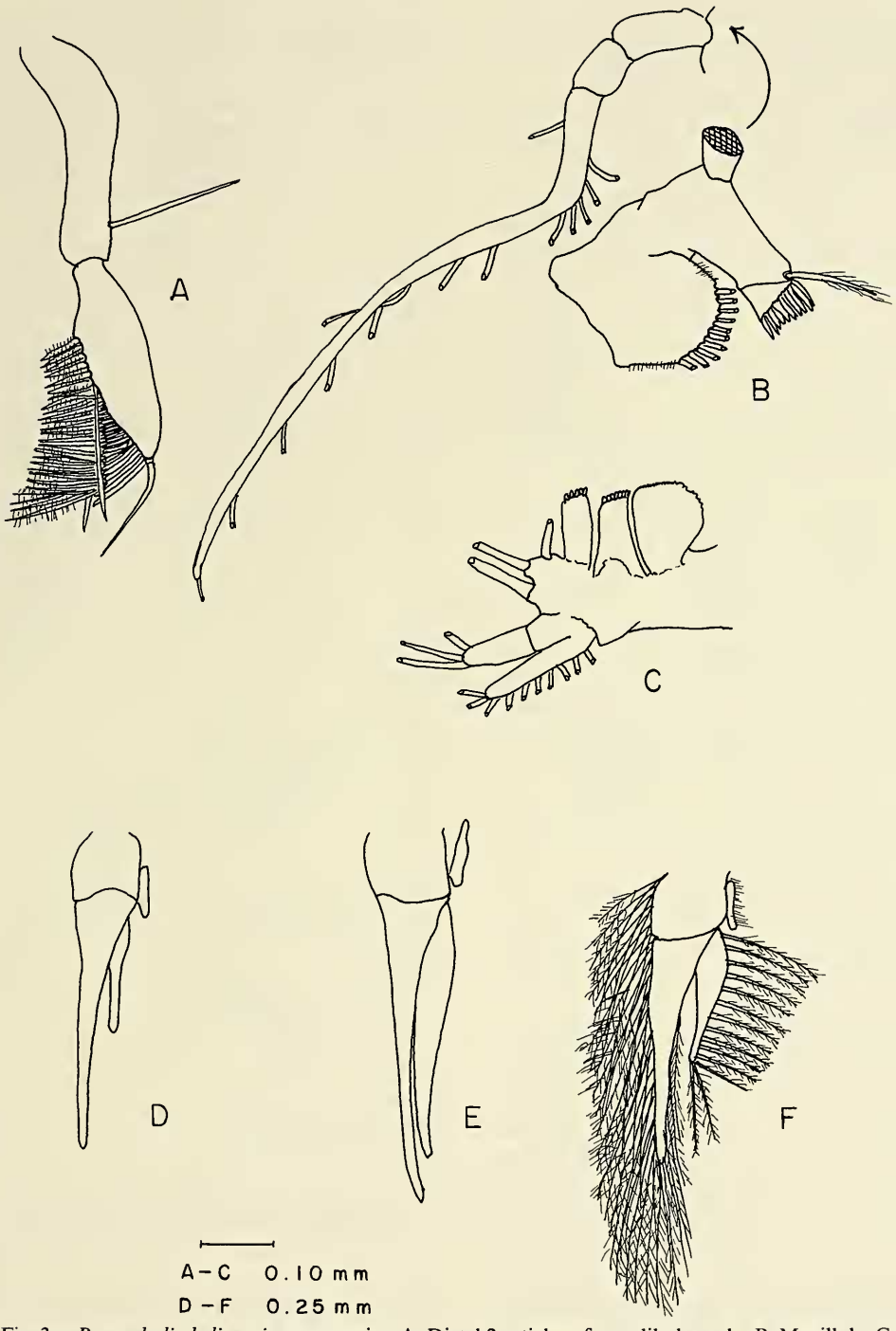

Fig. 3. *Paranebalia belizensis,* new species: A, Distal 2 articles of mandibular palp; B, Maxillule; C, Maxilla; D, Thoracopod 1 (marginal setation omitted); E, Thoracopod (marginal setation omitted) 4; F, Thoracopod 8. Female, 3.3 mm.

proximomedial retinaculum, lateral margin setose, distal margin with 2 short spines each with minute subterminal flagellum.

Pleopods 2, 3 and 4 similar, peduncle of each similar to pleopod 1. Pleopod 2, exopod 0.84 times as long as endopod (SE = 0.01, n = 12); endopod 0.93 times as long as peduncle (SE = 0.02, n = 12). Pleopod 3, exopod 0.94 times as long as endopod (SE = 0.04, n = 14); endopod 0.91 times as long as peduncle (SE = 0.05, n = 14). Pleopod 4 (Fig. 4B), exopod 0.99 times as long as endopod (SE = 0.05, n = 14), lateral margin with 6 pair of robust flagellated spines, distal 5 pair with adjacent single pinnate seta, robust terminal flagellated spine about twice as long as adjacent marginal spine; endopod 0.92 times as long as peduncle (SE = 0.04, n = 14), lateral margin setose, 2 terminal flagellated spines.

Pleopods 5 and 6 uniramous. Pleopod 5 (Fig. 4C), lateral margin with about 8 short flexed setae, distal margin with 3 robust flagellated spines and 6 short flexed setae, 3 short pinnate submarginal setae. Pleopod 6 (Fig. 4D), lateral margin distal half with 1 flexed seta, 3 pinnate setae and 1 thin spine with long subterminal flagellum, medial margin distal half with short robust spine and 2 flexed setae, distal margin with 2 robust spines each with minute subterminal flagellum, 1 thin spine with long subterminal flagellum, 1 thin spine with bulbous tip, and 2 flexed setae.

Pleonite 8 (Fig. 2) posterodorsal margin with medial symmetrical bulge.

Caudal ramus (Fig. 4E) 0.52 times as long as carapace (SE = 0.02, n = 12), lateral and medial margins setose with short flexed setae, distal end of medial margin serrated with small clump of minute setae at origin of serration, terminally 1 long flexed seta and 1 long thin naked seta submarginally.

Description male.—Smaller than female (mean total length = 1.96 mm, SE = 0.04, range = 1.5–2.4, n = 50), but structurally similar to female except for flagellum of antennule (Fig. 5A, B). Antennule flagellum greatly inflated, articulations between individual segments visible only near terminal nipple-like tip, distal half of ventral surface with row of 5 long filiform esthetascs and 4 subterminal pinnate setae, dorsal surface with subterminal clump of thin naked setae; flange on distal article of peduncle with fewer teeth.

Remarks.—Differences between *P. belizensis* and *P. longipes* are very subtle. Since previous systematic descriptions of *P. longipes* are very generalized and the characteristics defining individual species of *Paranebalia* have not been as well established as they have for *Nebalia* (Dahl 1985), I have noted only the most obvious differences between these two western Atlantic species. Some of the characteristics mentioned may not be of taxonomic value. However, they do differ consistantly from previous descriptions (Willemoes-Suhm 1875, Thiele 1904, Brattegard 1970, Wakabara 1976) and from *Paranebalia* (cf.) *longipes* specimens collected in the Florida Keys (Modlin, personal collection).

Six distinct differences in character structure of *P. belizensis* and *P. longipes* are shown in Table 1. In addition to these there is a consistent difference in total length between *P. belizensis* and *P. longipes*; *P. longipes* is about 60% larger than *P. belizensis*. However, the use of total length as a defining characteristic is questionable because neither Willemoes-Suhm (1875) nor Brattegard (1970) defined their total length measurements. Additionally, total length measurements tend to vary due to the expansion or contraction of the body during fixation and preservation. A more reliable measure might be the carapace length (C.L.). A highly significant ($P \ll 0.001$) relationship exists between the carapace length of *P. belizensis* and its total length (T.L.). The least squares linear regression, T.L. = 2.04(C.L.) + 0.03, defines this relationship (correlation coefficient = $r^2 = 0.97$, $n = 102$).

Figure 1B depicts two subterminal spines projecting from the rostrum. Two spines do

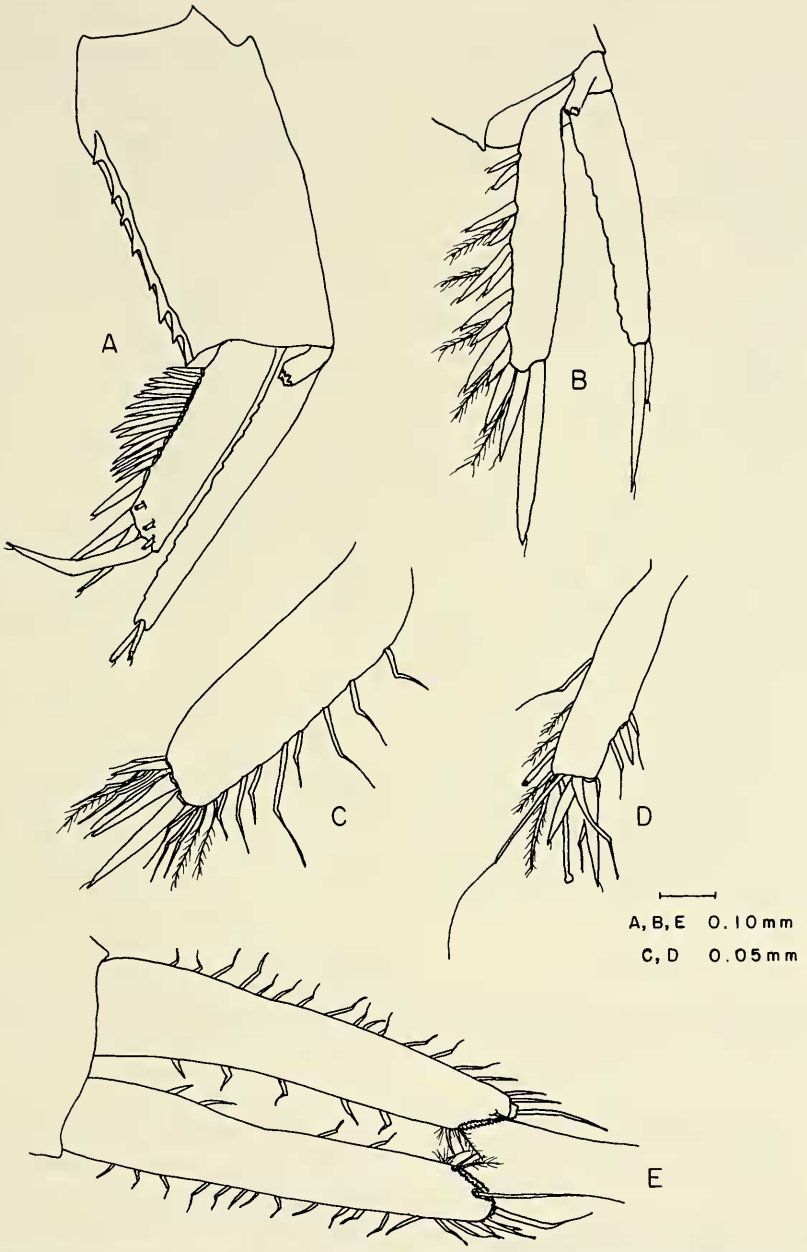

Fig. 4. *Paranebalia belizensis*, new species: A, Pleopod 1; B, Exopod and endopod of pleopod 4; C, Pleopod 5; D, Pleopod 6; E, Furca. Female, 3.3 mm.

exist on the drawn specimen and on others observed, but these spines are so closely superimposed upon each other that on most specimens they are difficult to distinguish separately without high-power phase contrast microscopy. Consequently, all descriptions to date indicate only a single spine. The presence of the second spine may indicate a premolt condition. However, a prominent ventral subterminal keel is pres-

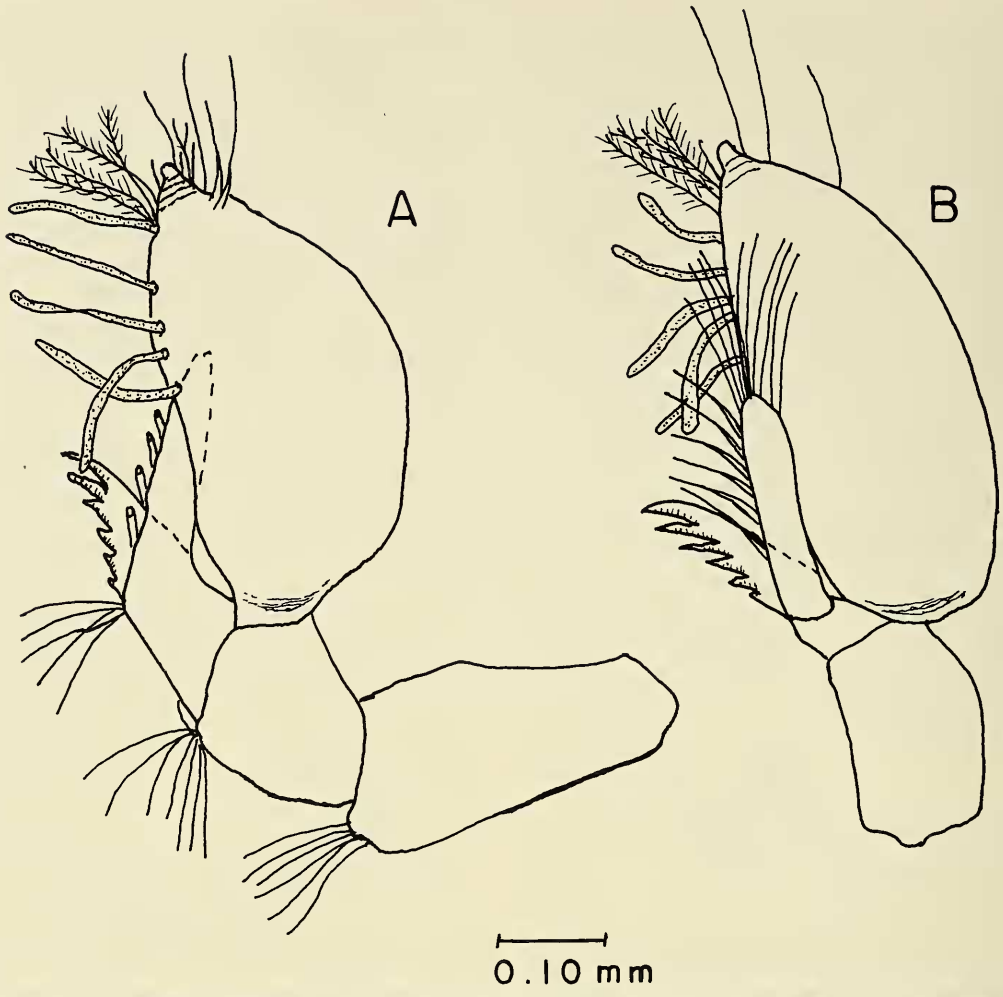

Fig. 5. *Paranebalia belizensis,* new species: A, Antennule, lateral view; B, Antennule, medial view. Male, 2.1 mm.

Table 1.—Characters distinguishing *P. belizensis* from *P. longipes.*

Character	*P. belizensis*	*P. longipes*
Antennule, 4th article, teeth in flange	7–10	10–12
Antennule flagellum, articles	6	7
Antennal flagellum, articles	5	9
Maxilla, endopod, proximal/distal lengths of articles	0.5	0.8
Length of teeth on posterior margins of pleonites 6 and 7	20 μm	33 μm
Setation on margins of furca	sparse	dense

ent on the rostrum of *P. longipes* but not on *P. belizensis.* Two prominant lateral spines consistantly occur on the 3rd article of the antennae of all size of *P. belizensis.* Plate IV, figure 7 published by Willemoes-Suhm (1875) depicts only one spine on this article, but figure 1C of Brattegard (1970) shows two. Specimens from the Florida Keys (R. Modlin, personal collection) are variable, some have one and others two. This difference does not seem to be size dependent.

The habitat of the two species differ. Although both appear to prefer the quiet wa-

ters of isolated or enclosed bays, *P. belizensis* was almost exclusively collected with the algae *Halimeda* growing on proproots of the red mangrove tree. Bottom sediments in the bay inhabited by *P. belizensis* are composed of soft, flocculant organic silt. The habitat of *P. longipes* ranged from a shell-coral rubble substrate in Harrington Sound, Bermuda (Willemoes-Suhm 1875) to calcareous muds, sand and *Thalassia* in the Bahama Islands and Florida Keys (Brattegard 1970, Modlin, personal observation). Although a variety of *Halimeda* spp. do occur in the communities sampled by other authors, the exact micro-habitat *P. longipes* prefers is unknown. Collections of Willemoes-Suhm (1875), Brattegard (1970) and others were made with epibenthic sledges or dredges, while all my observations and collections were made in situ snorkeling gear or SCUBA.

Ecological notes.—Specimens of *P. belizensis* were collected from different locations in the Twin Cays archipelago, but the species was almost exclusively associated with beds and suspended clumps of the algae *Halimeda.* Few specimens were collected from clumps of *Caulerpa racmosa.* Based on abundance, the type habitat is an isolated bay identified as the Lair. This is a small (surface area about 0.3 ha), shallow (average depth about 1.0 m) bay completely surrounded by red mangrove trees, *Rhizophora mangle. Paranebalia belizensis* is more abundant in the lush clumps of *Halimeda* suspended from the proproots at the origin of the single narrow channel (width about 12 m) that allows the exchange of Lair water with open water. Lair water is highly eutrophic and contains much suspended particulate material flushed from the surrounding mangrove swamp during ebb tide. Wave actions are limited to ripples and moderate currents are tidally generated. Surface salinity ranges from 20‰ after rain to 40‰; temperature ranges from 24°C in December to 38°C in July. A complete description of the Twin Cays habitats can be found in Rutzler and Feller (1987/88) and Modlin (1990).

Etymology.—Named for Belize, the country in which *P. belizensis* was first collected.

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